U. S. DEPARTMENT OF COMMERCE
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION
WEATHER BUREAU
NATIONAL METEOROLOGICAL CENTER

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DATA AND FORMATS

OFFICE NOTE 25

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The National Meteorological Center produces data on a daily basis in the following forms:

A. Fields of data on magnetic tape

   1. ADP data
   2. Analyses and forecast

B. Card decks of data fields

   1. Card images on magnetic tape
   2. Punched cards

C. Visual display produced via

   1. IBM 717 Printer (or equivalent)
   2. Electronic Associates' Data Plotter
   3. Burroughs Corporation's Digifax System
   4. United Aircraft's Facsimile Converter Equipment

D. Teletype messages for transmission over teletype circuits via

   1. IBM S360/30 Communication System (NMC)
   2. Weather Bureau Communication System (DATAC)

Meteorological synoptic data in its processed form is the basic data used at NMC. It constitutes the "ADP" data and is one of the files on the "B3" data tape. Analyses and forecast fields produced from the ADP data, along with previously computed "guess fields" form the remaining files on this tape[1]. A series of these B3 data tapes are combined to form the "Stacked B3" data tape.

The concept of stacking data on magnetic tape was started on March 4, 1962. At that time, the data fields were written in the "full word" (one datum point per 36 bit machine word[2]) format. On 12Z, August 15, 1963, the field format was changed to "triple packed" (3 datum points per 36 bit machine word[3]) form and is the current format for archiving data fields.

Prior to 1962, data was preserved only on punched cards. These "card decks" were periodically packed and shipped to the Federal Records Center (Washington, D.C.) for storage. Data on cards were in "quarter packed" format (4 datum points per 36 bit machine word[4]) until the 1963 conversion to "triple-word" format.

Starting in May, 1962, card decks of analyses and forecast fields were written as "card images" on magnetic tape. Both methods, i.e., stacking B3 data tapes and writing card images on magnetic tape, are being utilized for archiving.

Visual display in the form of maps and/or charts is produced from the ADP, analyses and forecast data. The earliest computer-formed display at NMC was the "map" of equally spaced "grid values" printed on the IBM 717 printer. Groups of numbers added between these "grid values" to form "contour bands" resulted in a chart depicting meteorological phenomena on which it is easy to hand draw "contours". The contour print program[5] is currently used as a standby and for program check-out. The resulting charts are not saved except for research work.

In December, 1960, NMC put its EAI data plotting equipment[5] into operation to assume part of the task of "drawing contours" and "labels". The magnetic tape-driven data plotter works from a tape generated on the IBM 7094 from analyses and forecast data and produces a contour chart in about ten to fifteen seconds. Charts produced via the data plotters are saved at NMC for three months. They are then put on microfilm and sent to Ashville for archiving[6].

1. Appendix 1
2. "Standard Structure of the JNWP 1981 - Word DATA Field (Revised)", J. R. Neilon
3. Appendix 2
4. Appendix 3
5. "Automatic Production of Contour Charts", H. A. Bedient and J. R. Neilon
6. Appendix 4

The "Digifax equipment" became operational on November 24, 1965. The digifax system is comprised of a combination of devices used to produce microfilm recorded weather maps, process the film and transmit the information via facsimile transmitters. Input to the system is a magnetic tape of analyses and/or forecast data generated on the IBM 7094. "Aperture cards[7]" made from the microfilm are periodically boxed and stored at NMC.

The newest in map producing equipment at NMC (Oct. 10, 1967) is the facsimile converter equipment designed by United Aircraft[8] which reads digital data recorded on a magnetic tape. This data is read into a facsimile encoder and transmitter which in turn makes the conversions acceptable to facsimile transmission. Charts produced by this system are periodically transfered to microfilm. Both original and microfilm are sent to Ashville for archiving[9].

The IBM S360 System with its associated teletype circuits receives the previously mentioned meteorological synoptic data. In its processed form, it becomes the input for the objective analysis program. The analyzed results and the forecasts made from these analyses become the input for programs which formulate "teletype messages". These messages which are written onto magnetic tapes and/or punched into five channel (chad) paper tape are then entered on the teletype circuits thru the IBM S360 or in the case of paper tape, transmitted locally by way of the data speed equipment to the Weather Bureau Communication System and entered on the teletype circuits at that point. Teletype messages are preserved for 24 hours on magnetic tape with the exception of the Air Transport Association (ATA) message which is preserved in printed form for fifteen days.

The discussion above describes the various data formats which are produced at NMC. Concurrent with the re-programming of all operational runs for the CDC 6600, the format for the basic ADP data (Office Note 20) and the field format will change. An update to Appendix 2 on data field format will be forthcoming.

7. Appendix 4
8. Office Note 27
9. Appendix 4

APPENDIX 1

Format of Stacked B3 Data Tape

Computer operations at NMC use a series of magnetic tapes during the routine processing of data. One of the main tapes in this series is known as "The B3 Data Tape" (1). The "stacked B3 Data Tape", as the name implies, is one magnetic tape containing data from several individual B3 Data tapes.

Data for one week is stacked on four tapes (2 for 00Z data and 2 for 12Z data). Data for three days (00Z) are on tape 1 and the remaining four days (00Z) are on tape 2. Likewise for 12Z data.

One day's data includes the following:

1. Final Guess file
2. Final ADP data
3. Operational analyses
4. Operational forecast thru 36 hrs.

All data fields are in triple-packed format.

(1) Office Note 26.

APPENDIX 2

Format of the NMC Triple Packed Data Field

The NMC triple-packed data field is composed of three parts: 1) two 36-bit words called pre-identifiers. 2) N 36-bit words of data packed in three 12-bit bytes per word. 3) four 36-bit words called post-identifiers. Each byte of 2) consists of a sign bit and 11 bits of datum value. The magnitude of this value is determined by the position of the binary point as indicated in word 4 of the post-identifiers.

The pre-identifiers were previously described in the memorandum "NMC Field Identifiers" (W344, Jan. 11, 1967) by J. Neilon. The post-identifiers have been described in the article "Standard Structure of the JNWP 1981-word Data Field (Revised)" by J. Neilon. Portions of these descriptions follow:

Pre-identifiers

Word	Bits	Contents
1	S,1,..,17	± binary tau right justified + means data was generated from data available at the time in the data record(1).
	18,..,26	Grid area (size and shape).
	27,..,35	Data type in Binary(2).
2	S,1,..,8	Pressure level (upper if thickness).
	9,..,17	Pressure level (lower if thickness or blank).
	18,..,35	Output type(3).

Code (Octal)	Grid
000	1977 point octagon
001	1679 point tropical grid (73x23)
002	1752 point tropical grid (73x24-displaced)
003	483 point tropical grid (95°W-5°E)(21x23)
004	483 point tropical grid (175°E-85°W)(21x23)
005	483 point tropical grid (85°E-175°W)(21x23)
006	483 point tropical grid (5°W-95°E)

(1) Office Note 26
(2) Attachment #1
(3) The output type is only necessary if a data field is to be used as input to one of the NMC output programs which produces print, punch, or curve drawn output.

Value of Byte	Type
1	Print
2	Curve drawer
4	Punch

or combination of above.

Post-identifiers

Word	Bits	Contents
1	S,1,..,17	binary tau right justified (always positive or zero)
	18,..,35	additive constants (atmospheric standard in meters when data is height or stream)
2	S,1,..,8	Hour of initial data
	9,..,17	Day of month (initial data)
	18,..,26	Month of initial data
	27,..,35	Year (century not included)
3	S,1,..,8	Forecast hours after initial time (4-bit BCD equivalent of binary tau-word 1, bits S,..,17)
	9,..,17	pressure level (upper if thickness)
	18,..,26	pressure level (lower if thickness or blank)
	27,..,35	data type (agrees with pre-identifier, word 1, bits 27-35)
4	S,1,..,8	Code number of program which generated data(4)
	9,..,17	Operational run time (5)
	18,..,26	Not used
	27,..,35	binary scale factor (i.e. position of binary point assuming each 12 bit datum byte left justified in a 36 bit word (counting from left).

(4) Attachment #2
(5) Attachment #3

Attachment #1

NMC DATUM FIELD IDENTIFIERS

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4-bit BCD	4-bit BCD in Octal	Type of Data	Units
1	1	Height (D-value)	CM (see table for ref. ht.)
2	2	Stream (D-value)	(F/G)*PSI (CM)
3	3	*Stability	
4	4	Thickness (D-value)	CM (see table for ref. ht.)
5	5	Vertical velocity	Microbars/sec.
6	6	Geostrophic wind speed	Knots
7	7	Difference (Height or stream)	CM
8	10	Absolute vorticity	900*ETA
9	11	Vorticity advection (Jacobian)	
10	20	Temperature	Degrees C
11	21	Dewpoint temperature	Degrees C
12	22	*Analyzed U- and V-components	Meters/sec.
13	23	Analyzed wind speed	Knots
14	24	*Vorticity from U and V	
15	25	*Divergence from U and V	
16	26	*Relative vorticity	
17	27	*Divergence	
18	30	Velocity potential	(F/G)*CHI (CM)
19	31	Temperature-dewpoint	Degrees C
20	40	*Cloudiness and Precipitation	
21	41	Precipitation amount	Centi-inches
22	42	Saturation thickness	CM (see table for ref.ht.)
23	43	Saturation thickness deficit	CM
24	44	Tropopause temperature	Degrees C
25	45	*Tropopause height	
26	46	Tropopause pressure	Centibars
27	47	*Tropopause pressure altitude	
28	50	Sea level pressure (990)	SLP-900 mb
29	51	**U,V, and T at constant height	
30	60	U-component of wind	Knots
31	61	V-component of wind	Knots
32	62	**ADP pressure	
33	63	Isentropic pressure	Centibars
34	64	Isentropic temperature	Degrees C
35	65	Montgomery stream	See Tech. Memo 30
36	66	Isentropic absolute vorticity	See Tech. Memo 30
37	67	Isentropic potential vorticity	See Tech. Memo 30
38	70	Isentropic pressure difference	Centibars
39	71	Max-min temperature guess	Degrees F
40	100	Potential temperature	Degrees K
41	101	Vertical shear speed	Knots/5000 ft.
42	102	Difference pressure	Millibars
43	103	Trope wind shear	Knots/1000 ft.
44	104	Relative humidity	Percent/100
45	105	Precipitable water	Hundredths of inches
46	106	Theta	Degrees A-273

4-bit BCD	4-bit BCD in Octal	Type of Data	Units
47	107	Sea surface temperature	Degrees C - (neg. over land)
48	110	P*SFC. pressure	Centibars-90
49	111	Lifted index	Degrees C
50	120	Height of terrain (mountains)	Meters
51	121	Pressure of terrain (mountains)	MB
52	122	Thermal wind (2-LVLS)	
53	123	Snowfield	Flag (1=Snow, 0=No snow)
54	124	Tropical to Northern Hemisphere streams (D-value)	CM (see table for ref.ht.)
55	125	Wind wave hgt. (sea hgt.)	Ft.
56	126	Hgt. (sea swell)	Ft.
57	127	Combined wave hgt. (wind wave/ swell)	Ft.
58	130	Long wave component of hgt.field	CM
59	131	Long wave component of error field	CM
60	140	Short wave component of hgt.	CM
61	141	Short wave component of error	CM
62	142	Net vertical displacement	

** Special field for operational use
* Not currently used

This list obsoletes previous lists.

REFERENCE HEIGHTS FOR NMC D-VALUES

	ADP		ANAL.	
Level (mb)	Decafeet	Meters	Decafeet	Meters
1000	37	113	37	113
850	478	1457	478	1457
700	988	3011	988	3011
500	1828	5572	1828	5572
400	2356	7181	2356	7181
300	3005	9159	3005	9159
250	3398	10357	3398	10357
200	3866	11784	3866	11784
150	4468	13618	4468	13618
100	5317	16206	5317	16206
70	6065	18486	5965	18181
50	6769	20632	6619	20175
30	7839	23893	7639	23283
20	8688	26481	8438	25719
10	10188	31053	9888	30139

Note: The reference heights used in ADP and ANAL. are not identical for levels above 100 mb.

Special Markers (Pre id, word 2, bits S, 1, .., 8.)
990 (231 octal) Mountains, Surface
980 (230 octal) Tropopause

Attachment #2

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CODE NUMBER OF PROGRAM GENERATING DATA

BCD	OCTAL	NAME OF GENERATING PROGRAM
00	00	Objective Analysis
01	01	Barotropic Forecast model described in NMC Office Note 15
02	02	Mesh Model 1958 described in NMC Office Note 15
03	03	Mesh Model 1964 (with improved terrain) described in Office Note 24
04	04	Reed 1000 mb Forecast model described in NMC Tech. Memo 26
05	05	3-level Baroclinic Forecast model described in NMC Tech. Memo 22.
06	06	4-level Baroclinic Forecast model (GPC)
07	07	4-layer PE Equation model (Shuman)
08	10	6-layer PE Model (Shuman)
09	11	Max. and min. temperature forecast (TDL)
10	20	Sea height and swell forecast (TDL)
11	21	Tropical analysis
12	22	Tropical forecast
13	23	BAT analysis
14	24	Tropical forecast (Collins)
15	25	Tropical forecast with satellite modification (Collins)
16	26	Sub-synoptic advective model

Attachment #3

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OPERATIONAL RUN TIME

CODE (OCTAL)	RUN
1	Operational (3 hrs and 25 min after 00Z or 12Z)
4	RADAT (1 hr and 20 min after 00Z or 12Z)
10	RAOB (2 hrs and 50 min after 00Z or 12Z)
40	Final (10 hrs after 00Z or 12Z)

APPENDIX 3

FORMAT OF DATA CARD DECKS

The following is a description of punched card decks (or card images on magnetic tape) of data fields computed on the NMC octagonal grid. The cards (images) are punched (written[1]) in row binary form. Each card deck contains a face plate (figure 1) and several information cards. The number of information cards depends on whether the data is packed four bytes (quarter-packed, 25 information cards), three bytes (triple-packed, 34 information cards), or two bytes (half-packed, 50 information cards) per 36 bit machine word (figures 2 and 3). Each byte is a datum point consisting of a sign (bit 1 counting from the left) and the datum value except for the last four 36 bit words which are the "post-identifiers[2]". The position of the binary point indicates the magnitude of the data and is determined from byte 4 of the fourth "post-identifier".

Each information card contains twenty words of data starting at row 7 left (figure 4), and proceeding to row 7 right, row 6 left, etc. Row 8 is blank on all cards. Row 9 contains the following information:

Columns 1 thru 3 -	Relative binary if bit in column 2. If bit in column 3, ignore the check sum.
Columns 14 thru 18	Word count for the card.
Columns 22 thru 36	Loading address for that card.
Columns 37 thru 72	Card ACL sum. (See SHARE 704 Standards).

The number of cards in a deck is determined as follows:

$$[(\text{GRID} \div \text{N}) + 4] / 20 = \text{Q} + \text{R}$$

where

1. GRID is the NWP octagon of 1977 datum points.
2. N is the number of bytes (datum points) per 36 bit word.
3. 4 is the number of (36 bit word) post-identifiers.
4. 20 is the number of 36 bit words per card.
5. Q is number of full card images.
6. R is number of 36 bit words on the last card. If R is less than or equal to 4, the last card will contain post-identifiers only, otherwise it will contain both data and post-identifiers (figure 5).

The face plate contains information in columns 73 thru 80 corresponding to words 2, 3 and 4 of the post-identifiers (figure 1). This information is gang punched into columns 73 thru 80 of each of the succeeding cards.

As aforementioned, the data corresponds to points on the 1977 point NWP octagonal grid. The first datum point of the first word on the first card is the datum for the grid point at the lower left hand corner of the grid. The grid row is then read from left to right. The next row is read from left to right and so on, so that the last datum point is for the grid point in the upper right hand corner of the grid.

(1) Card images on magnetic tape are written without end of record gaps so that each deck, rather than each card image, is a record on tape.

(2) A full description of the "post-identifiers" is given in Appendix 2.

FACE PLATE

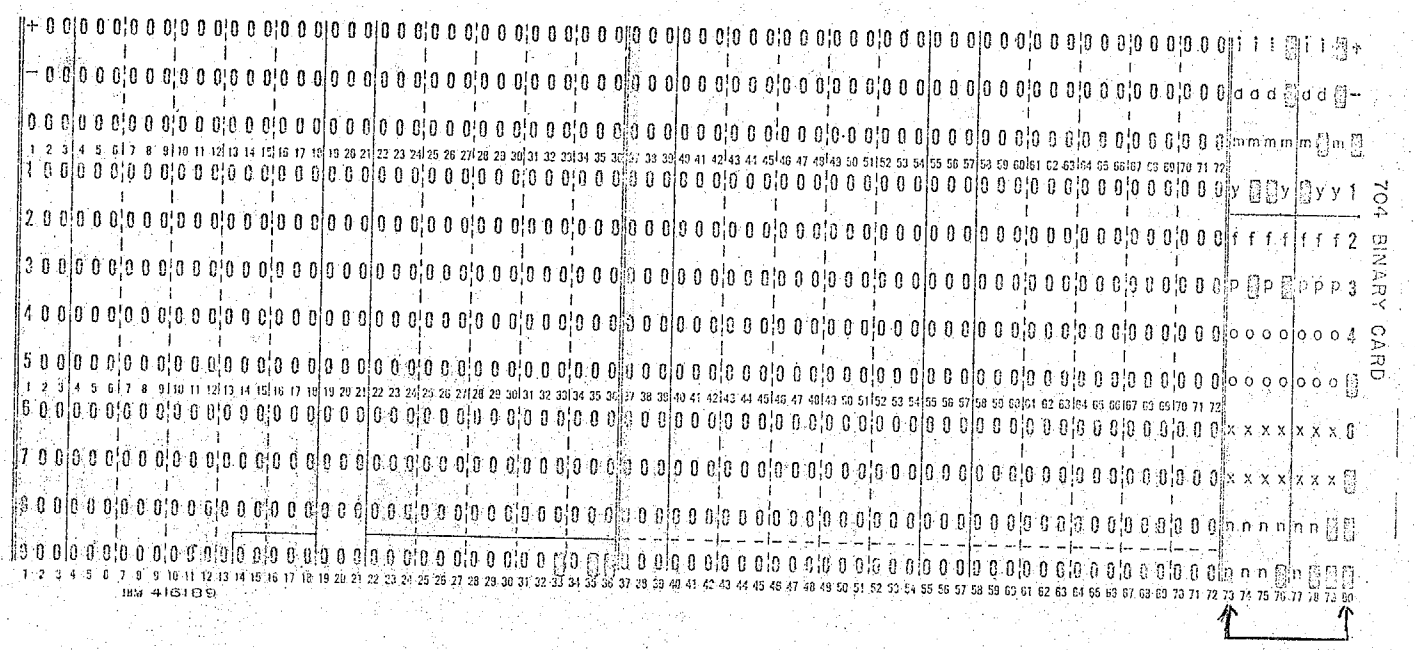
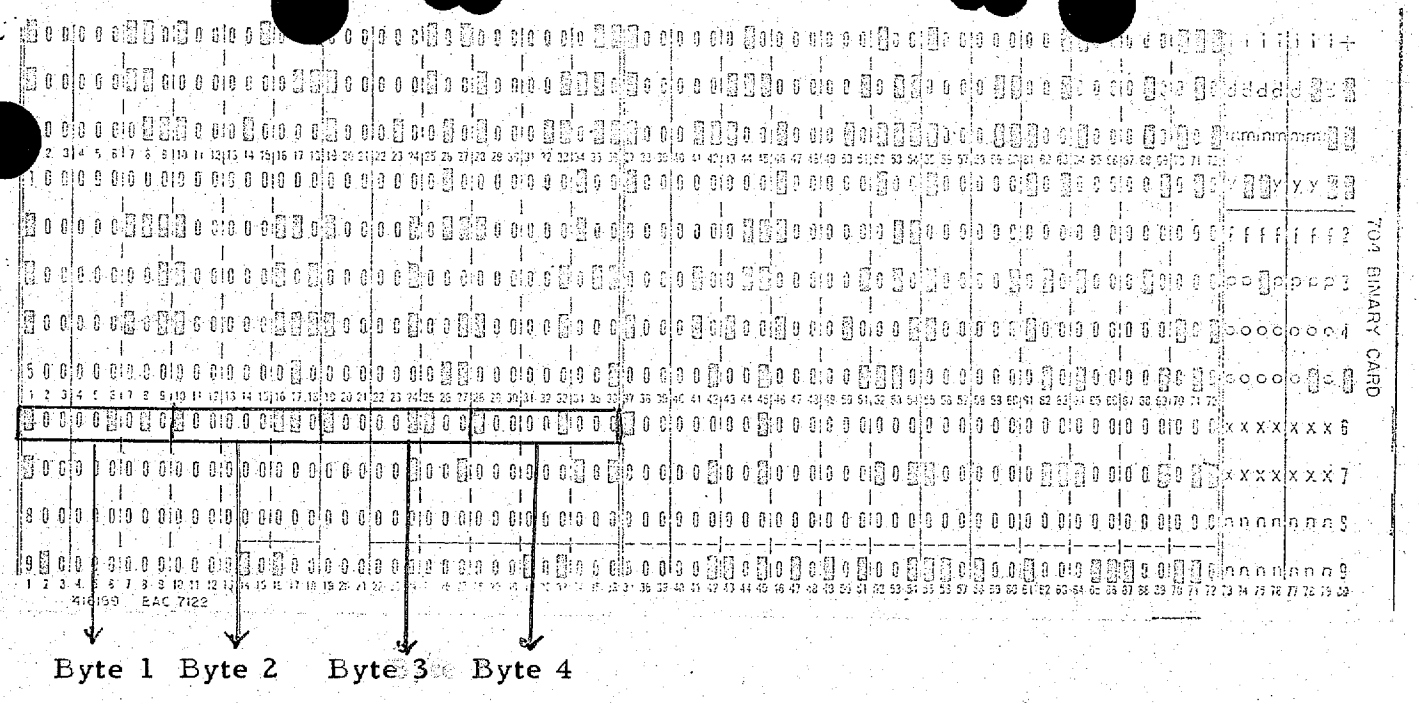


Figure 1

Columns 73 thru 80 (Words 2, 3, and 4 of post identifiers). These columns are gang punched into all succeeding cards.

4 BYTES PER 36 BIT WO



3 BYTES PER 36 BIT WORD

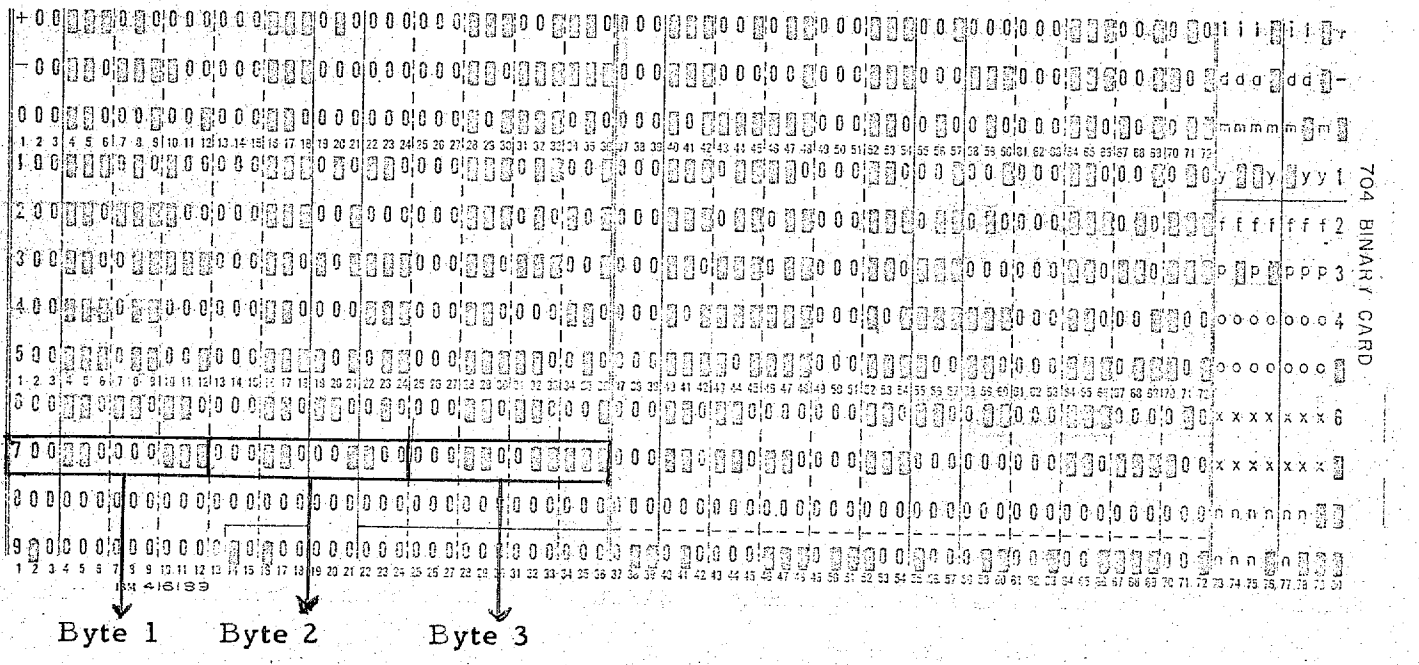


Figure 2

2 BYTES PER 36 BIT WORD

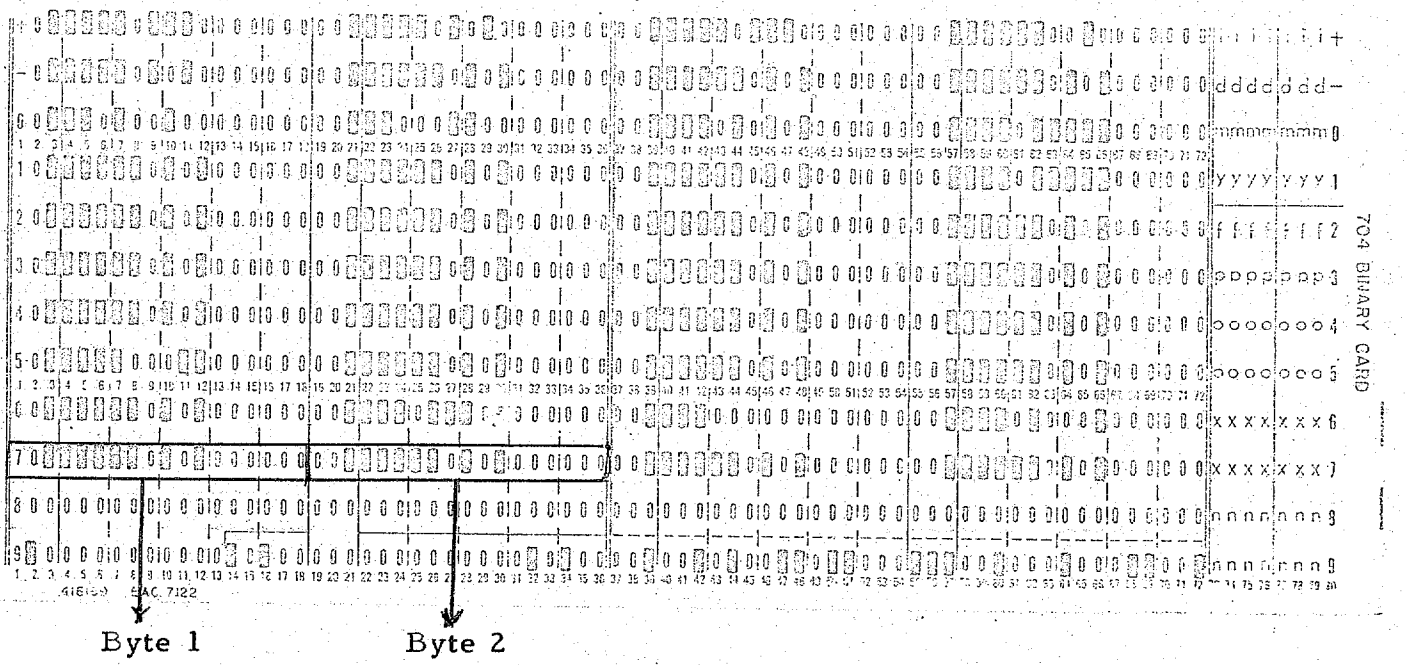
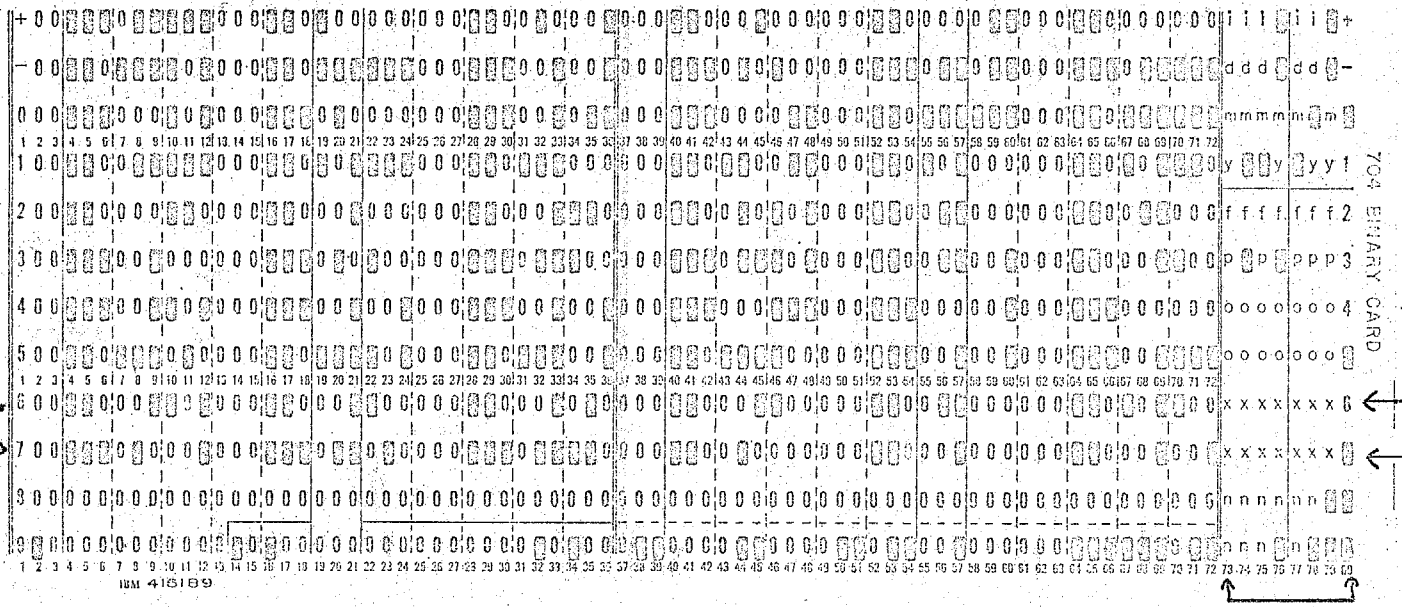


Figure 3

EXAMPLE OF AN INFORMATION CARD (3 BYTES PER WORD)



Etc.

Row 6 left

Row 7 left

Row 8 -
blank on all cards.

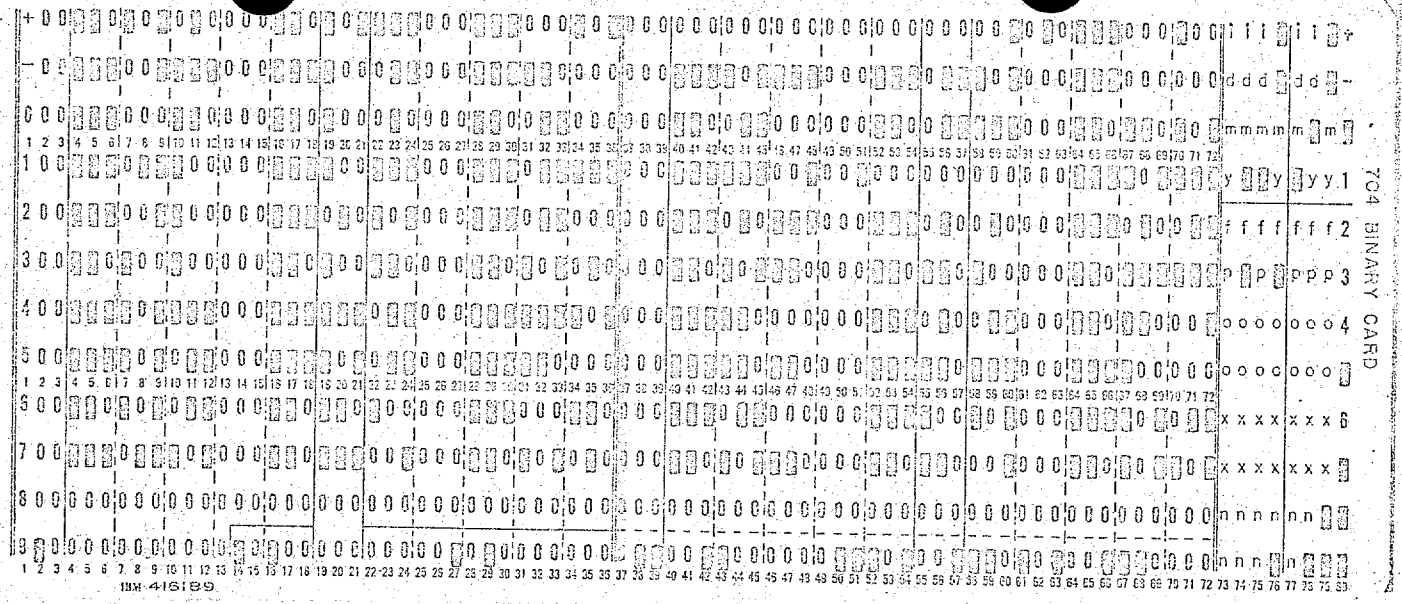
Row 6 right

Row 7 right

Columns 73 thru 80
(Post identifiers - word
2, 3, and 4)

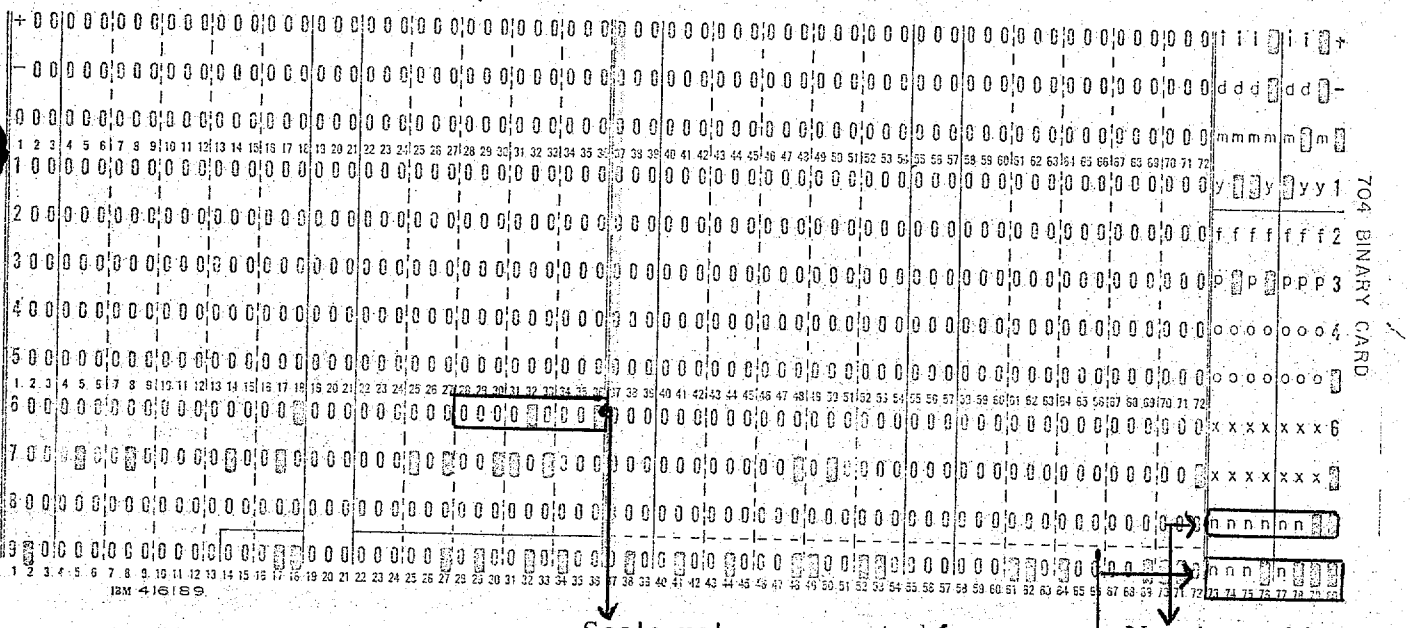
Figure 4.

NEXT TO LAST CARD



This card contains data and word 1 of post identifiers

LAST CARD



This card contains words 2, 3, and 4 of post identifiers

Figure 5

APPENDIX 4

HARD COPY

Figure 1 is a sample of a map produced on the EAI Data Plotter Equipment. The actual chart size is 28" by 30". The map bases currently in use are:

1. 1/30,000,000 Polar Stereographic Projection, true at latitude 60°,
2. 1/20,000,000 Polar Stereographic Projection, true at latitude 60°, and soon to be added:
3. 1/15,000,000 Polar Stereographic Projection, true at latitude 60°.

The following charts, produced twice daily, are saved in the Numerical Weather Prediction Analysiz (NWP) Section of NMC:

850 mb)
700 mb)
500 mb) Analyzed Heights, Temperatures and Winds
300 mb)
200 mb)
100 mb)

36 hr. 500 mb Forecast Heights and Winds

At the end of three months, these charts are transfered to microfilm. The microfilm and the original charts are sent to Ashville for archiving.

Figure 2 is a sample of a map produced by the Burroughs Corporation Digifax System. The actual chart size is 18" by 18". The map base used for the Northern Hemisphere Charts (P.E.) is the same as for charts produced on the Data Plotter Equipment. A 1/20,000,000 Mercator Projection, true at 22.5° N and S, is used for the Tropical areas. Tropical charts are produced in four panels, each representing ¼ of the globe. Figure 3 shows an "aperture" card containing a frame.from a processed film. This aperture card is made by cutting an opening in an IBM 80 column card just large enough to exactly contain one frame. The following data is saved on aperture cards and archived at NMC:

700 mb)
500 mb) 4 panels each, Tropical Analysis (Opn'l and Final),
300 mb) Heights, Temperature and Winds
200 mb)

700 mb)
300 mb) 4 panels each, Tropical Forecast Streams
250 mb)

Charts produced on the United Aircraft Corporation Facsimile Converter Equipment (figure 4) use the same map base as those produced on the Digifax Equipment. The chart size is variable. The following charts are produced twice daily:

700 mb	Heights and Temperatures
300 mb) 200 mb)	Heights, Winds and Temperatures

Forecast winds and temperatures (FD) aloft at 8 different levels.

The 700, 300, and 200 mb charts are kept at the NMC for three months. They are then transfered to microfilm for archiving at Ashville. The FD Winds and Temperatures are not saved.

For more detailed information on the current map producing programs, see Office Note 27.

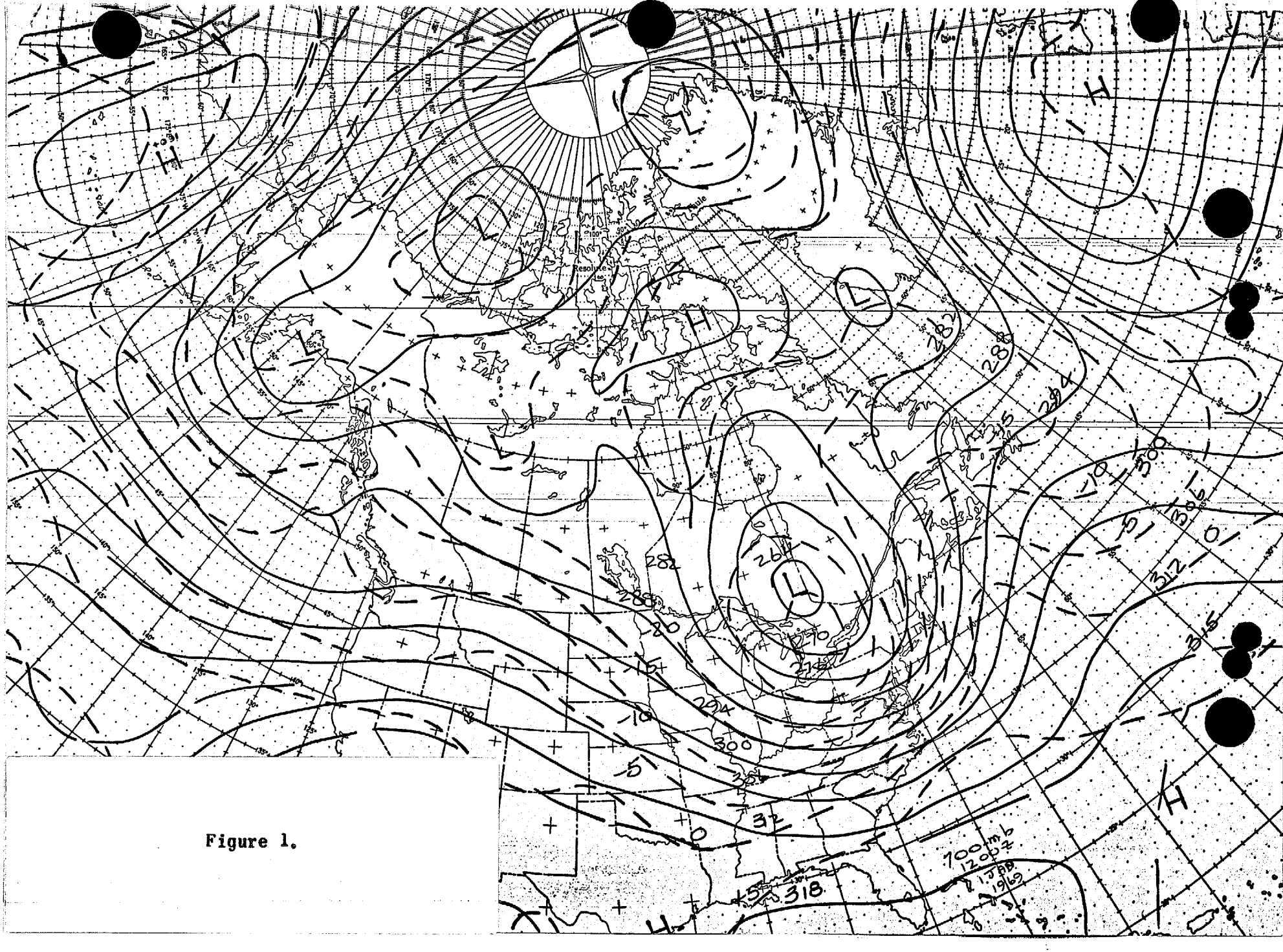


Figure 1.

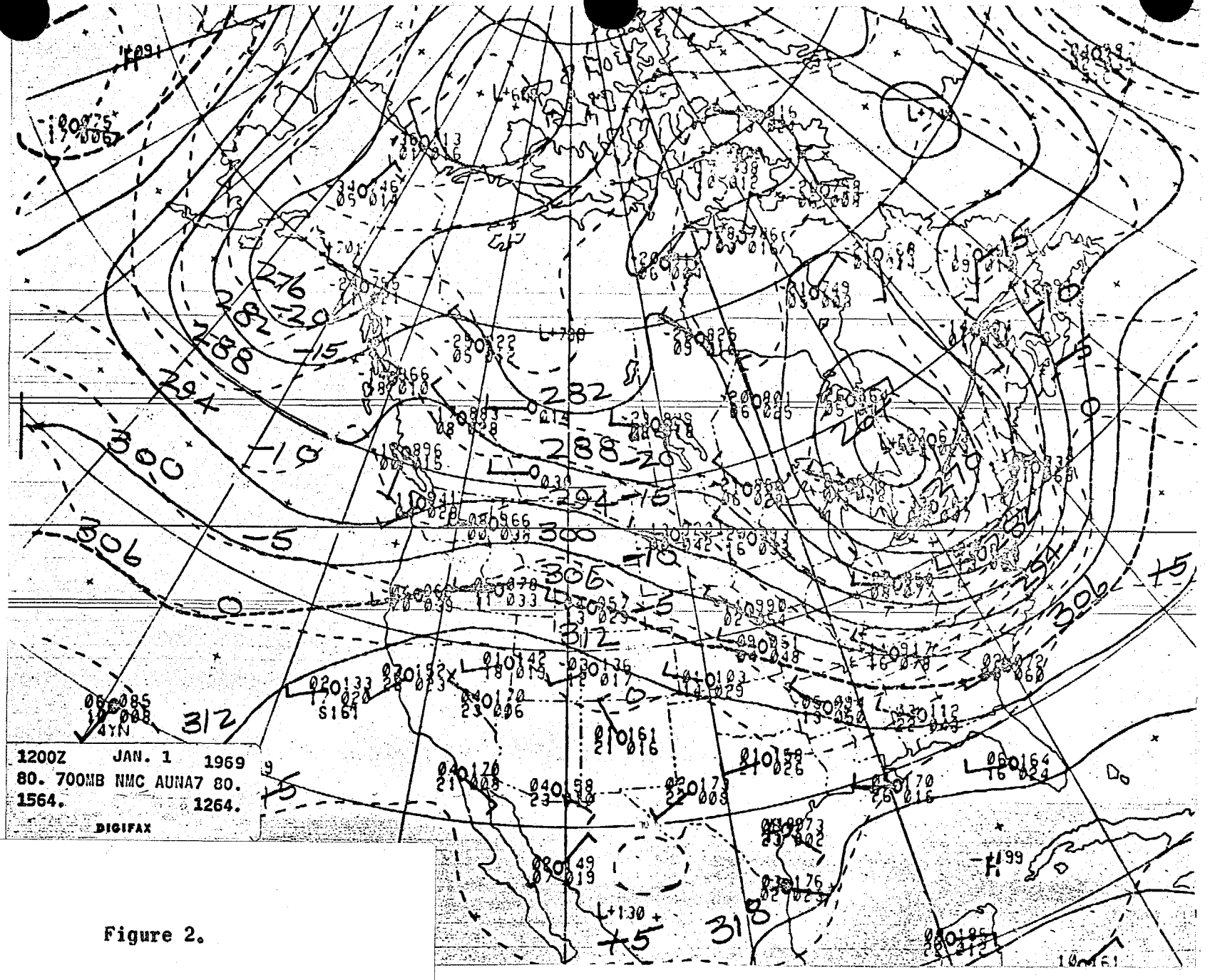
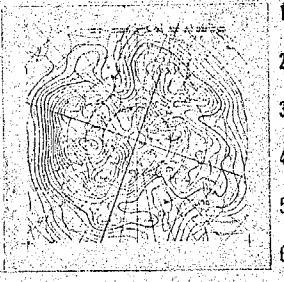


Figure 2.

Winds & Heights	500 MB	24	4	3	66	122		
TYPE OF DATE	LEVEL	FCST. HR.	DATE			TIME	RUN	COPIES

TYPE OF DATA	LEVEL	FCST. HOUR	DATE MO.	DATE DA.	DATE YR.	TIME	RUN	COPIES



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MMM 1540 "FILMSORT" BRAND APERTURE CARD PRODUCT OF 3M CO. ST. PAUL 6, MINNESOTA U.S. PAT. NOS. 2,511,859; 2,512,108; 2,587,022

Figure 3.

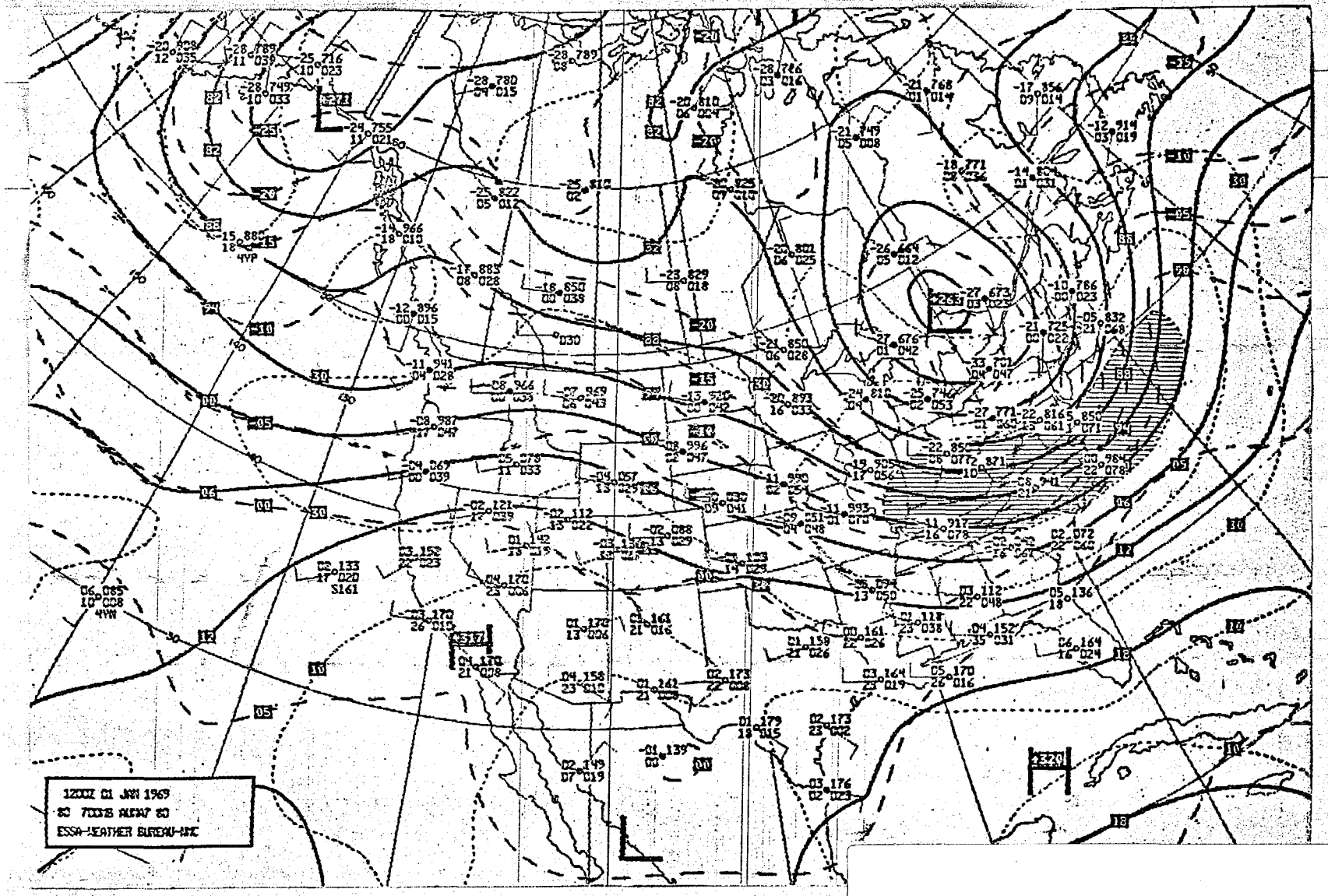

Figure 4.